33. (New) A method for forming a CVD-TiN film according to claim 31, wherein said atmosphere with said non-reactive gas with said tantalum oxide comprises gases other than the NH_3 gas.

34. (New) A method for forming a CVD-TiN film according to claim 31, wherein said atmosphere of non-reactive gas with said tantalum oxide comprises one gas selected from a rarified gas including nitrogen, argon, hydrogen gas, or a mixture of these gases.

35. (New) A method for forming a CVD-TiN film according to claim 30, wherein said non-reactive gas is a mixture of titanium tetrachloride ($TiCl_4$) and NH_3.

36. (New) A method for forming a CVD-TiN film according to claim 30, wherein said tantalum oxide film is formed as a capacitive film of a capacitor element and said CVD-TiN film is formed as a plate electrode.

REMARKS

This paper is being provided as a supplement to Applicant's November 21, 2001 response to the August 28, 2001 Non-Final Office Action for the above-referenced application. In this supplemental response, Applicant has added new claims 30-36 in order to more particularly point out and distinctly claim that which applicant deems to be the invention. Applicant respectfully submits that the new claims are all supported by the originally filed application. In addition, Applicant has included herewith additional discussion regarding the claimed invention and the cited references.

The rejection of claims 1-11 and 13-29 under 35 U.S.C. §103(a) as being obvious over Tamaru et al (U.S. Patent No. 6,103,566, hereinafter referred to as "Tamaru") in view of Nishikawa et al. (U.S. Patent No. 6,087,261, hereinafter referred to as "Nishikawa") and further in view of Lee et al. (U.S. Patent No. 6,010,940, hereinafter referred to as "Lee") is hereby traversed and reconsideration thereof is respectfully requested. Applicant respectfully submits that the claims, as amended herein, are patentable over the cited references, whether taken separately or in any combination.

The cited art of Tamaru discloses a DRAM with a capacitive element that is protected from breakdown under the influence of a TiN film that is CVD deposited on the capacitor dielectric as a passivation film to prevent the dielectric from making any contact with the nitrogen containing reducing gas (please see col. 3, lines 25 - 49).

The Office Action indicates that the Tamaru reference shows that ammonia is a known ambient, and states on page 3 of the office Action that it "would have been obvious to one having ordinary skill in the art at the time the invention was made to have modified Tamaru's vacuum pressure at less than 1 because a better non-reactive ambient can be obtained at the lower vacuum pressure". Applicant respectfully disagrees with the suggestion in the Office Action that Tamaru describes or suggests a non-reactive ambient.

Applicant respectfully submits that the Tamaru reference teaches using an oxidizing titanium source gas ambient to form a metal layer prior to the introduction of any reducing gas such as ammonia, in order to prevent the disassociation of the metal oxide film by a reducing ambient. Thus the cited reference does not describe or suggest using a non-reactive ambient, as suggested incorrectly by the Office Action.

Tamaru discloses the use of ammonia to passivate (i.e., not a non-reactive process, but rather a nitridation process that forms a new material) the polysilicon lower electrode (col. 2, lines 10-24), and thus the suggestion in the Office Action that the use of ammonia in Tamaru represents a non-reactive ambient is incorrect. Applicant further notes that Tamaru contains no suggestion of any ammonia or reducing gas used after the dielectric is formed (col. 3, lines 30 -49; col. 4, line 20) until a oxygen containing titanium source gas has covered the metal oxide with the upper electrode (col. 18, lines 33- 40). The Tamaru reference states that the metal oxide should not come into contact with reducing gases such as ammonia, and thus directly teaches against the recited features of the claimed invention. Thus, Tamaru is an inappropriate reference for a number of reasons.

Additionally and by way of comparison, Applicant respectfully submits that the present claimed invention sets forth that when the CVD-TiN film is formed on an oxide metal, the oxide metal is first heated within an NH3 gas or a gas that is non-reactive to the oxide metal. Thereafter, a source gas is supplied to the oxide metal, which grows the TiN film thereon. In this manner, the TiN film is formed directly on the oxide metal.

On the other hand, the cited reference Tamaru discloses that an oxide metal is heated within a gas that is non-reactive to the substrate. Thereafter, a protective film is formed on the oxide metal by supplying a gas to the oxide metal that contains a Ti gas followed by forming a TiN film thereon by supplying a source gas and a reduction gas.

Since Tamaru discloses forming the protective film on the oxide metal followed by forming the TiN film on the protective layer, Applicant respectfully submits that the cited reference of Tamaru does not disclose a process for forming the TiN film or any other metal nitride film **directly** on the oxide metal, as set forth in Applicant's independent claims 1 and 30.

The cited art of Nishikawa has been discussed in prior responses, and discloses a method of forming a dielectric film on a semiconductor substrate in a reduced pressure atmosphere, and then depositing a metal or metal nitride on the dielectric. Nishikawa discloses that hydrogen, carbon and methane released as a normal part of the CVD deposition causes electrical leakage in the dielectric film. Nishikawa discloses that this electrical leakage problem is reduced by using oxygen containing gases (i.e., oxidizing with respect to the metal oxide) in the formation of the conductor film (col. 2, lines 18-27; col. 4, line 66; col. 9, line 15). Nishikawa states that this oxygen containing step is extremely important (col. 2, line 63). Thus applicant respectfully requests the Examiner to explain the suggestion in the second paragraph on page 4 of the present outstanding Office Action, that Nishikawa teaches using an inert ambient.

The Nishikawa reference discloses that using a reaction gas that contains oxygen (i.e., not a non-reaction ambient with respect to the metal oxide) at up to 5 sccm (col. 5, line 23) produces an oxygen containing metal film (i.e., a film that has been oxidized - a process that one of ordinary skill in the art would clearly recognize as not occurring in a non-reactive ambient) that does not have too high a resistivity to be a useful conductor. Thus the cited reference *clearly* teaches an ambient that is reactive.

Applicant respectfully submits that the suggestion on page 4 of the outstanding Office Action that "the limitation of non-reactive with respect to the metal oxide is not consistent with the claimed invention" is incorrect. The specification at page 1 and page 4 last paragraph, discusses the problem of leakage due to reactive gases on tantalum oxide film. In the section of the specification that deals with the experimental measurements made on the metal oxide leakage, the application notes on pages 7 and 8 and in table 3, that if the ammonia partial pressure is less than 1 Torr, the ammonia ambient is non-reactive with respect to the metal oxide. Thus, the suggestion in the Office Action that the claim language is inconsistent is clearly incorrect since the language and experimental facts supporting the claims language may be found in the specification, and this fact has been discussed previously in Applicant's last two responses.

Applicant respectfully submits that the cited Nishikawa reference teaches an oxidized metal that is not too resistive. Nishikawa does not teach a non-reactive ambient

Therefore, Applicant respectfully submits that the TiN film of Nishikawa is formed on a protective film after the protective film containing metal therein has been formed on the dielectric film. Therefore, Applicant respectfully submits that the cited reference of Nishikawa does not disclose a process for forming the TiN film or any other metal nitride film **directly** on the oxide metal, as set forth in Applicant's independent claims 1 and 30.

The cited art of Lee discloses a method for making a TiN barrier for the upper plate of a capacitor to reduce the reactions between the metal oxide and the polysilicon upper electrode (col. 1, line 26). The TiN layer is disclosed as being formed using $TiCl_4$, which may form chlorine that may attack the metal oxide. The chlorine is reduced by use of an ammonia anneal which chemically attacks the chlorine (i.e., not a non-reactive ambient) and removes it as HCl gas. The anneal step is disclosed as occurring after the TiN deposition and not prior to metal deposition and thus not having any possible impact on the metal oxide layer, since one of ordinary skill would know that a metal layer is a barrier to chemical attack on the metal oxide dielectric layer below. Thus the Lee reference can not supply any motivation for one of ordinary skill to combine with references that oxide the substrate.

Applicant's independent claim 1 utilizes an inert ambient, which is clearly different from the cited reference. Specifically, independent claim 1, as amended herein, recites that "*...said method comprising a step of treating said substrate in an ambient that*

is non-reactive with respect to said metal oxide formed on said surface of said substrate in said chamber wherein said non-reactive ambient includes at least one of a gas non-reactive with respect to said metal oxide contained in said dielectric film and NH_3 gas ...", which is not suggested by any possible combination of the oxidizing ambient of the cited reference of Nishikawa, the TiN barrier of Lee, or the ammonia nitridation reaction of Tamaru. Independent claim 8 recites that "*...heating a substrate onto which said dielectric film is formed to a prescribed temperature in an ambient having a NH_3 atmosphere of no greater partial pressure than 1.0 Torr and no less than 0.1 Torr before the introduction of said source gas containing said high melting point metal ...*",which, for the same reasons given above with respect to claim 1, is neither described nor suggested by any combination of the cited references.

Applicant submits that if the ambient of the cited reference is intended and stated unambiguously by the cited reference to oxide or nitridate a layer, then it can not be non reactive towards the layer, as required in the claimed invention. There is no non-reactive ambient found in any of the suggested references, and thus even if there were some motivation to combine the references, the combination still does not provide the features of the present invention.

That the cited reference of Nishikawa teaches using an oxidizing ambient and thus not an ambient that is non reactive with respect to the underlying metal oxide is clear since the stated goal of the cited reference is to use the oxidizing gas to form (i.e., not a non-reactive ambient) the oxygen containing conductor film. The Nishikawa reference

explicitly states that the stabilization of the dielectric film obtained by using "the copious supply of the oxidizing gas" (col. 2, line 58) to prevent "deficiency of oxygen" (col. 1, line 62) in the dielectric film is "extremely important" (col. 2, line 63), thus clearly not suggesting use of a non oxidizing gas such as in the claimed invention. Applicant believes that this makes it clear to one of ordinary skill that the ambient used is non reactive with respect to the metal oxide rather than being absolutely inert in all respects.

Applicant further respectfully submits that the Lee reference discloses an anneal process that occurs after a TiN barrier layer is formed, and thus does not describe or suggest an anneal of the metal oxide, since the barrier is stated to protect the metal oxide. Lee teaches a method of chemically removing residual chlorine gas in a vacuum system. Applicant respectfully submits that such a reference does not provide motivation for one of skill in the art to combine with other cited art since it does not teach protecting the metal oxide film from reducing ambients as disclosed in the cited references.

Therefore, applicant respectfully submits that independent claims 1 and 8, as amended herein, are not obvious over the suggested combination of cited references, specifically that the suggested combination of references discloses the use of oxidizing or nitridating ambients that are reactive to the underlying metal oxide layers and thus have barriers. Dependent claims 2-7, 9-11 and 13-29 are held to be patentable at least as depending from base claims shown above to patentable over the suggested combination of references.

Therefore, for reasons set forth above, applicant respectfully requests that this rejection be reconsidered and withdrawn.

Based on the above, applicant respectfully requests that the Examiner reconsider and withdraw all outstanding rejections and objections. Favorable consideration and allowance are earnestly solicited. Should there be any questions after reviewing this paper, the Examiner is invited to contact the undersigned at 617-951-6676.

Respectfully submitted,
HUTCHINS, WHEELER & DITTMAR

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